

# **Manufacturing Management The Head-Waters for Technical/Vocational Education**

***Dr. David Hillis***  
*East Carolina University*

## **Synopsis**

Global competitive pressure is causing manufacturing management in the United States to adopt new methods for organizing and controlling the factory. These new methods of management will redefine the knowledge and skills people need to work in these industries. Consequently, changes in management ultimately determine the educational needs of those working in industry. The issues raised for vocational education can be illustrated by examining the changes that swept through industry at the beginning of this century. At that time Taylor and Ford introduced two new concepts for organizing and controlling the workplace that together radically changed the skills, knowledge, and work habits needed by those employed in manufacturing industries. Nearly a century has passed, and industry is once again changing its approach to management. Understanding the different approaches to manufacturing management and how each approach defines work provides vocational and technical educators with insights to educational needs of those seeking careers in manufacturing.

## **Introduction**

The pressure for continuous improvement is causing significant change in the way manufacturing companies are managed (Gibson, 1990). Many industries are rapidly downsizing to adjust to changes in the markets they serve. Some changes are in response to the defense industry's need to reorient to commercial and industrial markets. However, most changes are directed at meeting global competitive pressure requiring: (a) increased productivity, (b) the introduction of "breakthrough" methodologies, and (c) newly developed technologies (McLagan, 1989, 1991). To support change, manufacturing management is altering the ways it organizes and controls workplaces (Gibson, 1990). Changes in management will ultimately determine educational needs of those working in industry. Understanding the different approaches to manufacturing management and how each approach defines work provides vocational and technical educators with insights to educational needs of those seeking careers in manufacturing. More importantly, educators can detect shifts in educational needs if they are able to recognize when significant changes are underway in management methods.

To illustrate, consider a period of significant change in manufacturing management that occurred at the end of the last century. At that time manufacturing shifted from a craft to a factory-based system of production. This change in manufacturing significantly altered skills and knowledge workers needed to be productive. Vocational educators responded by providing programs that taught needed skills and knowledge (Evans & Herr, 1978). John Dewey, however, was deeply concerned about these changes in education. He challenged the approach taken by vocational education as too specific to the technology of the time and too limiting for a democratic society (Wirth, 1972).

Manufacturing management systems are again undergoing significant changes. The magnitude of the effects may be assessed by understanding how management systems define the knowledge and skills required. Also Dewey's insight on the relationship between industry and education provides another view on manufacturing management's impact on vocational education.

### **Manufacturing Management**

At the turn of this century, the United States had a well established industrial base that was serving an expanding national market (Marcus & Segal, 1989). Although the nation was growing in size and prosperity, industry was having difficulty finding qualified people to work in manufacturing plants. Therefore, manufacturing management was being pressed to consider new ways to increase capacity and productivity (Babcock, 1990). This led to methods that required management to change approaches to the factory system of the nineteenth century.

### **Factories, Systemization, and Technical/Vocational Education**

The factory system of the nineteenth century came into existence because of eighteenth century innovations (Babcock, 1990). Five of these innovations were inventions that facilitated the manufacture of textiles which essentially eliminated the commercial need for the crafts associated with making cloth. The other three innovations: the steam engine, the screw-cutting lathe, and the concept of interchangeable assembly influenced manufacturing in general. Specifically the steam engine, along with the concept of interchangeable parts, made possible the factory system which created complex work-places that substantially increased the number of people working within organizations (Babcock, 1990; Borgmann, 1984).

The work-place created by these inventions was not the cottage industry that the seventeenth and eighteenth century philosophers had envisioned as the means that men and women would use to earn a living (Hall, 1967). The change over from local cottage industries to centralized factories significantly changed the nature of work both in skills required and constraints on personal activity (Marcus & Segal, 1989). Consequently, the factory created a need for two forms of training. Factory managers had to train workers to acquire manufacturing skills and to develop the "habits of industry" such as regular attendance and punctuality (Babcock, 1990, p. 23). During the later half of the nineteenth century, industry recognized that (a) normal education was not supplying these vocational skills and habits and (b) this training would need to be an ongoing process to support the country's economic expansion (Miller, 1987).

### **Redefining the Nature of Work**

By the end of the nineteenth century, the factory system had a problem more serious than acquiring trained workers. Managers found it difficult to organize and control their plants in part because the factory system significantly increased the complexity of organization. With the possible exception of the textile industry, which was more process oriented, most manufacturing was labor intensive, relying on many craft and skill groups. Each of these skill groups confounded management by retaining control of the work-place (Noble, 1984). Specifically the skill groups were able to significantly influence the rate of production and the use of resources such as material and labor.

In the film *Clockwork: The Making of a Modern American Work-Place* (Breitbart, 1982), actual film footage of factory scenes from the beginning of this century illustrate the chaotic nature of the work-place. It's apparent from the scenes in the film which show vast amounts of work-in-process, that the activity of the organization was not under any system of coordinated control – the skill and craft groups were operating independently of each other.

The film goes on to demonstrate how control was reestablished by the introduction of Frederick Taylor's concept of "Scientific Management." Although the film emphasizes time study, this was only one part, albeit a significant component of Taylor's theory of management. His major contribution was the recognition that jobs could be broken down into simple elemental tasks. This fragmentation of work created jobs that were repetitious, less skilled, and easily sequenced (Gibson, 1990). The result helped management eliminate skill and craft groups while improving the means to assess the rate of production. Taylor's complete work, "Shop Management," was presented at the Saratoga meeting of the American Society of Mechanical Engineers in June of 1903 (Niegel, 1958). This paper on manufacturing management was well received and widely read (Babcock, 1990).

In 1913, Ford Motor Company expanded on Taylor's methods by introducing a new approach to manufacturing. Ford began by applying Taylor's concepts of scientific management to assembly of automobiles. Next, Ford rigidly sequenced and paced manufacture by linking all the assembly tasks together with a moving conveyor (Marcus & Segal, 1989). When placed in operation this method created an integrated manufacturing system called the assembly line. The result caused Ford's output to increase dramatically. When other companies adopted this system, they also experienced the benefits of reduced skill requirements and improved productivity and control.

The two concepts (Taylor's concept of work and Ford's concept of mechanically sequencing and pacing of production) may be considered in combination as one technique and will be characterized in the context of this paper as the "Taylor-Ford" approach to manufacturing management. The Taylor-Ford approach resulted in significant reductions in the degree of skill and responsibility required in workers and redefined the nature of factory work. The result enabled management to wrest control from skilled and craft workers by transforming their jobs into elemental tasks which were sequenced and paced by manufacturing machinery and equipment (Noble, 1984). With the Taylor-Ford approach, management was able to create and control larger manufacturing facilities (Niegel, 1958).

### **Manufacturing Management's Influence on Educational Needs**

Although the Taylor-Ford system reduced skill levels significantly and simplified organization, there was still a very strong need for worker education. The response to this need for education can be viewed as two separate components. First there was a training component that is described by Babcock (1990) as the learning of skills and habits of industry. Currently the responsibility for this component is increasingly being recognized as belonging to industry (McLagan, 1989). However, at the turn of the century, industry was looking to public education to accept this responsibility (Evans & Herr, 1978).

The second aspect focuses on the impact the Taylor-Ford approach had on the nature of work. The success of this approach caused it to become a paradigm for manufacturing that defined skills, knowledge, and habits needed by factory workers as very job specific. Therefore, vocational education at the turn of the century reflected the needs of the Taylor-Ford approach.

The constraints that this paradigm placed on vocational education and industry may be demonstrated by consideration of an alternative and more contemporary system for managing factories. Richard Schonberger (1986), a widely read author on manufacturing management, put forth a very different approach on how factories should be operated. In essence his approach places a portion of management responsibility on each worker while emphasizing teamwork, just-in-time manufacturing, and continuous improvement. If Schonberger's approach to manufacturing management and control had been chosen 90 years ago, the knowledge and skills needed would have been very different.

### **Another Perspective**

If manufacturing managers had been implementing Schonberger's (1986) concepts for world-class manufacturing at the beginning of this century, Dewey's proposals for

vocational education as described by Wirth (1972) would certainly have been more relevant. However, at the beginning of this century vocational education's response to industry as put forward by Prosser and his colleagues was more appropriate for that period. The essence of Prosser's philosophy of vocational education is contained in his 16 theorems (Camp & Hillison, 1984). These theorems have very specific aims such as providing job skills and work habits that enable persons to move directly into the work place from school. Prosser and Quigley (1949, pp. 11-12) provided a descriptive assessment of vocational education when they compared it directly to general education. In this discussion they saw six areas that differentiated the two forms of education. These points are summarized in Table 1.

**Table 1**

***Comparison of Vocational Education to General Education  
(Prosser & Quigley, 1949)***

**Controlling Purpose –**

General education: prepares one to live more intelligently, understand life, and enjoy life.

Vocational education: prepares one to work more efficiently.

**Subject Matter Taught –**

General education: should give the general information needed to help one learn about life and vocations.

Vocational education: gives specific training in the usable skills and knowledge for each occupation.

**Groups Served –**

General education: designed to serve everyone while they are compelled to be in school. After that period is passed, anyone may continue if they are benefiting from it.

Vocational education: given successfully only to those who are preparing for such employment or who are already employed in the field.

**Methods of Instruction –**

General education: reading and reciting.

Vocational education: experiential and skill development.

**Sequence –**

General education: precedes vocational education and serves as a foundation.

Vocational education: gives point, purpose, significance, and application to general education.

**Fundamental Psychology –**

General education: advocates believe general mental faculties can be developed best by the mastery of traditional subject matter and taught as formalized disciplines. The course of study that prepares a student for college is also suitable for preparing one for life.

Vocational education: the mind is a habit-forming machine which learns through practicing habits of doing and thinking to accomplish ends in which the learner is interested.

An examination of the comparisons in Table 1 shows, not surprisingly, that subject matter taught for vocational education is job specific. This approach to vocational education conceptually supports and parallels the Taylor-Ford approach to manufacturing management. However, it is difficult to envision how the job-specific subject matter, methods, and psychology could support Schonberger's approach to manufacturing.

Dewey challenged this educational process from the onset and continued to oppose Prosser's approach to vocational education even though it was gaining public, state, and federal support that culminated in passage of the Smith-Hughes Act in 1917 (Wirth, 1972). Two of Dewey's concerns were undemocratic tendencies and the two-tiered society that he thought would develop when general education was separated from vocational education. Dewey also made direct challenges of industry's use of the Taylor-Ford approach. Dewey questioned fragmentation of jobs and called for redesign of industry's definition of work and education (Wirth, 1974). Dewey in *Reconstruction in Philosophy* (cited in Wirth, 1974) saw specialization resulting from this fragmentation as a way of tracking and limiting the all-around growth of individuals in society. He believed that this fragmentation could ultimately destroy democracy.

Snedden (cited in Wirth, 1974), Prosser's colleague and mentor, provided a counter argument by observing that industry's growth was the foremost means for human progress. Industry, in Snedden's view, did subject men and women to fragmented and routine tasks, but this specialization was allowing them to improve standards of living. Snedden's reply was that good jobs and good pay couldn't harm democracy and that, thus, the educational process was justified.

Dewey, *Liberalism and Social Action* (cited in Wirth, 1974), however, was still concerned about the pecuniary motives and the "corrosive" materialism of society that this whole concept of work fragmentation and specialization brought to education and industry. In *Democracy and Education* (cited in Wirth, 1974) Dewey indicated that educational reorganization should not be directed toward providing technical preparation for industries as they currently operate, in part because this job-specific education will perpetuate current conditions and inhibit change. The difficulty in instituting change to new technologies and methodologies is the very problem that industry is trying to overcome today. Dewey's solution called for social reconstruction based on collaborative participation between industry and education and aimed at liberating the mind.

Dewey's comments are relevant to current approaches to manufacturing organization and control. Many of the current approaches to manufacturing management and control, such as self-directed work teams, etc., are causing reconsideration of basic definitions of work (Gibson, 1990). The skills needed for new forms of work include problem solving, decision making, and interpersonal behavior skills coupled with broad technical skills. Manufacturing work as it is currently evolving is not unlike Dewey's observations, particularly those in his later writings.

During World War II, Dewey began to develop a philosophical approach to manufacturing and examined this topic in several essays. Dewey observed that industrial technology had outstripped social knowledge and our ability to use it for the benefit of society (Dewey, 1944b). In another essay Dewey (1944a) saw the development of the arts of production as being technologies which should be viewed as part of a system of knowledge needed by each worker.

## Conclusion

From a manufacturer's point of view there are two separate issues, training and education. At the turn of the century industry managed to combine these issues into one. The result thrust the responsibility for training onto vocational education. Furthermore, the concept of work devised by manufacturers also dictated a very specific approach to education.

Nearly a century has passed and industry is again changing its approach to management. These changes are causing manufacturers to redefine the nature of work. However, after 90

years, manufacturing has begun to accept more responsibility for providing job-specific training (Miller, 1987). Consequently, vocational education will not have to concentrate on teaching habits and practice but may focus on developing the system of knowledge that Dewey (1944a) proposed.

To assure success of this approach, vocational educators must understand the principles and the body of knowledge that governs manufacturing and manufacturing management. This is particularly apparent when manufacturers, based on their current approach to manufacturing management and control, are again trying to impose educational methods and content such as the NCMS's manufacturing curriculum for the year 2000 (National Center for Manufacturing Sciences [NCMS], 1990). Understanding different approaches to manufacturing management and how each defines work provides vocational and technical educators with insights to the educational needs of those seeking careers in manufacturing. This understanding also provides opportunities to work collaboratively with industry to provide education.

## References

- Babcock, D. L. (1990). *Managing engineering and technology*. Englewood Cliffs, NJ: Prentice Hall.
- Borgmann, A. (1984). *Technology and the character of contemporary life*. Chicago: University of Chicago Press.
- Breitbart, E. (Producer), & Breitbart, E. (Director). (1982). *Clockwork: the making of a modern American work place* [Film]. San Francisco: California Newsreel.
- Camp, W. G., & Hillison, J. H. (1984). Prosser's sixteen theorems: Time for reconsideration. *Journal of Vocational Technical Education*, 1 (1), 13-21.
- Dewey, J. (1946a). By nature and by art. In J. Dewey (Ed.), *Problems of men*. New York: Philosophical Library. (Original work published 1944)
- Dewey, J. (1946b). The democratic faith and education. In J. Dewey (Ed.), *Problems of men*. New York: Philosophical Library. (Original work published 1944)
- Evans, R. N., & Herr, E. L. (1978) *Foundations of vocational education* (2nd ed.). Columbus, OH: Merrill.
- Gibson, J. E. (1990). *Modern management of the high technology enterprise*. Englewood Cliffs, NJ: Prentice Hall.
- Hall, A. R. (1967). Cultural, intellectual and social foundations 1600-1750. In M. Kranzberg & C. W. Pursell (Eds.) *Technology in western civilization*. (pp. 107-117). New York: Oxford University Press.
- Marcus, A. I., & Segal, H. P. (1989). *Technology in America a brief history*. New York: Harcourt Brace Jovanovich.
- McLagan, P. A. (1989). Models for HRD practice. *Training and Development Journal*, 43 (9), 49-59.
- McLagan, P. A. (1991). The dark side of quality. *Training*, 28 (11), 31-33.
- Miller, V. A. (1987). The history of training. In R. L. Craig (Ed.) *Training and development handbook* (pp. 3-18). New York: McGraw Hill.
- NCMS. (1990). A manufacturing curriculum for the year 2000. *Focus*, 3 (8), 6-7.
- Niebel, B. W. (1958). *Motion and time study*. Homewood, IL: Irwin Inc.
- Noble, D. F. (1984). *Forces of production: A social history of industrial automation*. New York: Knopf.
- Prosser, C. A. & Quigley, T. H. (1949). *Vocational Education in a democracy*. Chicago: American Technical Society.
- Schonberger, R. J. (1986). *World Class Manufacturing*. New York: The Free Press.
- Wirth, A. G. (1972). John Dewey's philosophical opposition to Smith-Hughes type vocational education. *Educational Theory*, 22 (1), 69-77.
- Wirth, A. G. (1974). Issues affecting education and work in the eighties: Efficiency versus industrial democracy, a historical perspective. *Teachers College Record*, 79 (1), 1-14.